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№ 3

Economic Intelligence Report

# TECHNOLOGY IN POST AND TELECOMMUNICATIONS IN THE USSR 1959–80

CIA/RR ER 62-12

April 1962

CENTRAL INTELLIGENCE AGENCY
Office of Research and Reports

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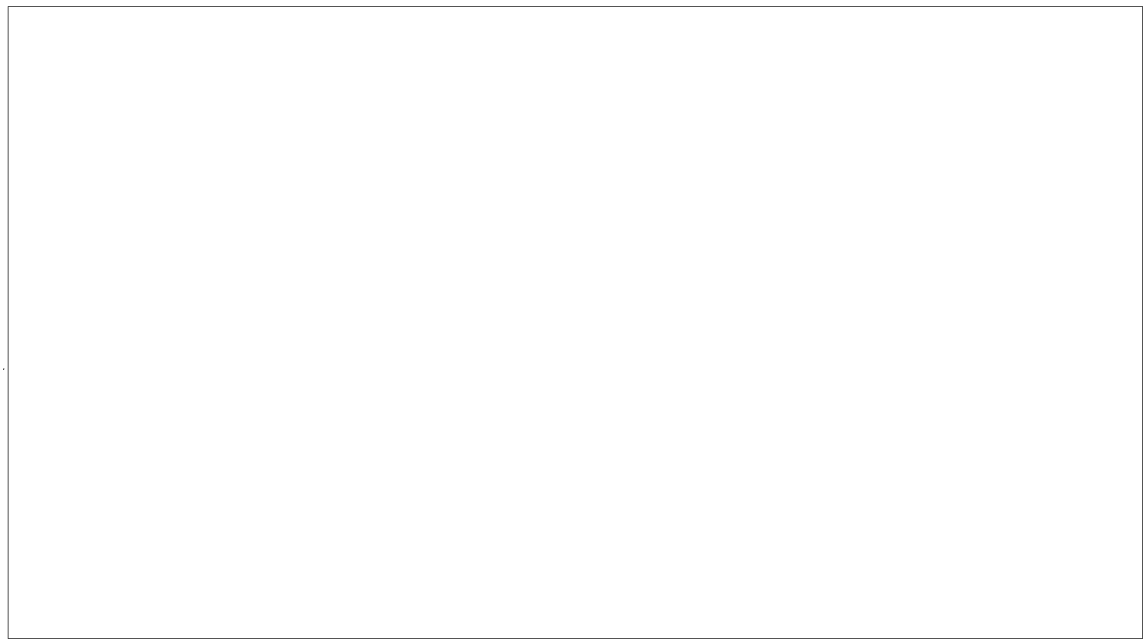
## FOREWORD

Soviet planners are giving increased attention to technology (automation, mechanization, and modernization) as a means of maintaining a high rate of economic growth. It is the purpose of this report to review the scope and magnitude of some of the more significant technological plans for the post and telecommunications sector and to evaluate the economic implications of these plans.



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# TECHNOLOGY IN POST AND TELECOMMUNICATIONS IN THE USSR* 1959-80

## Summary and Conclusions

Under the Seven Year Plan (1959-65)** the USSR, for the first time, has begun extensive exploitation of modern technology (automation, mechanization, and modernization) for the post and telecommunications sector of its economy.*** The overriding objective of the Plan is to commence the building of a new arterial communications base, somewhat comparable in technological stature to those found in Western countries today. The capacities of this base will then be available over the long term for absorption by the rapidly growing needs of the economy and also by other sectors of government, including the military.

The whole sector has long suffered from low priority. It has not been able to give the amounts of service or the kinds and quality of service long judged to be needed by the Ministry of Communications to support fully rapid economic growth. Heretofore, expansion of facilities has been in small, high-cost-per-unit increments, largely devoid of built-in slack for the future. The choice of media for long-distance telecommunications service had been confined largely to open wire lines and conventional point-to-point radio circuits.

For building the new base the choice of technology will be influenced, as expected, by the full weight of practical economics. From the technologies chosen (multiconductor and coaxial cable and microwave radio relay media) the USSR expects to obtain very large additional service capacities at low unit cost, greater labor productivity, lower operating costs, and improved speed and reliability of service.

Specific technological provisions of the Plan include the following: automated broadcast stations, automatic and semiautomatic telephone and telegraph exchanges, automated common carrier lines, modern telegraph apparatus, and mechanized and automated mail-handling equipment.

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* The estimates and conclusions in this report represent the best judgment of this Office as of 1 April 1962. For a definition of technical terms, see the Glossary of Technical Terms, Appendix A.

** Hereafter referred to as the Plan.

*** The post and telecommunications sector is operated and maintained by the Ministry of Communications, which, for the purposes of this report, includes both the Ministry of Communications of the USSR and the ministries of communications of the various republics of the USSR.



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Progress made during the first 3 years of the Plan indicates the probable fulfillment of the whole Plan. Realization of technological goals of the Plan will improve the coverage, speed, and quality of post and telecommunications services. But, with the exception of subscriber telegraph and broadcasting services, not much improvement is foreseen in the availability of service, especially to the public. Growth in revenue and labor productivity will not be much better than that of the 1952-58 period, because the provision of telephone and telegraph equipment will lag behind the construction of the high-capacity lines on which the equipment ultimately will be used. This lag should disappear rapidly after 1965.

Technological developments in the post and telecommunications sector after 1965 generally will follow lines similar to those of the Plan, but more advanced technologies also will be introduced. These may include the following: microminiaturization of components for communications equipment, all-electronic switching equipment, high-speed data transmission systems, extremely broadband transmission systems using long-distance waveguide and optical masers, and communications satellites.

Raising the level of technology in the post and telecommunications sector will ramify throughout the Soviet economy. The provision of specialized services tailored to meet the needs of the Soviet economy, such as teledata, telecontrol, and telemetering, will revolutionize the speed, timing, and accuracy of economic planning and day-to-day operational control and coordination. Furthermore, the requirements of the general public for some kinds of communications services will be satisfied.

Communications technology in the USSR lags roughly 10 years behind that of the US. The lag cannot be written off as sheer backwardness. The interconnection problem in a communications system varies geometrically with system size. For the much larger system of the US, therefore, the press of economics on technological progress is likewise geometrically larger. Thus the US was forced, technologically, to move ahead faster than the USSR. But, paradoxically, the existing lag is not without some compensation to the USSR, now that it begins to build a new modern system. It can adopt the most advanced Western technologies as appropriate, thus reducing developmental cost and saving valuable time. Because it did not, over the years, adopt many new technologies as they became available, the USSR avoids what otherwise would have been the economic cost of rapid obsolescence or, alternatively, the cost of achieving compatibility of a total system from a conglomerate of incompatible subsystems.

Over the long term it is expected that the USSR will reduce discernibly its present lag behind the US. But because the US will continue to exploit over the period the revolutionary developments in the field of electronic technology as they become economically attractive, it is doubtful that even by 1980 the lag will have been eliminated.



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## I. Introduction

The Ministry of Communications is responsible for the civil post and telecommunications sector of the Soviet economy. In the past, however, the Ministry has been restricted by a low priority. Pressing requirements for more and better service to support the rapidly growing economy have forced belatedly a decision to initiate a broad program of expansion, automation, mechanization, and modernization of the sector.

## II. Planned Technological Goals

The long-range technological goal of the civil post and telecommunications sector of the Soviet economy is the establishment of a fully automated telecommunications system and a highly mechanized postal system capable of meeting growing needs, both official and public. The Plan is the first to call for major steps in this direction.

### A. Plans, 1959-65

The technological goals for 1959-65 provide for the application of proved communications techniques. Although in the USSR before 1959 many of these techniques had not progressed beyond the stage of research and development, they were well-known and widely used in Western countries. The table* summarizes the specific goals of the USSR for increases in modern post and telecommunications facilities and for the degree of automation to be achieved.

The Ministry of Communications is giving primary emphasis in its plans to the establishment of an extensive arterial network of common carrier facilities employing a high degree of automation. Repeater points on cable lines and relay stations on microwave radio relay lines are to be unattended and remotely controlled. Multiplexing equipment will provide capacities of 1,920 telephone channels, per coaxial-pair, on coaxial cable lines; 12, 24, or 60 telephone channels, per cable-pair, on multiconductor cable lines; and 60 to 600 telephone channels, per radiofrequency trunk, on microwave radio relay lines. In addition, microwave and coaxial cable lines will be capable of carrying television transmissions. Toward the latter part of the Plan period, miniature coaxial cable lines are to be introduced. Using solid-state components in unattended repeater points, these miniature coaxial cable lines will have a capacity of 300 telephone channels.

Other significant common carrier developments will include single-sideband and tropospheric scatter radio techniques. On main and secondary

* The table follows on p. 4.



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Table

Post and Telecommunications Facilities in the USSR
1958 and 1965 a/*

| Type of Facility | Unit of Measure | End of 1958 | End of 1965 | Planned Increase (Percent) | Degree of Automation, 1965 |
|---|---|---|---|---|---|
| Common Carrier | | | | | |
| Microwave radio relay Cable | Kilometers | 3,270 | 27,500 | 740 | 70 percent of relay stations |
| Main and secondary | Kilometers | 37,400 | 74,800 | 100 | 70 percent of repeater stations |
| Rural | Kilometers | 300,000 | 2,300,000 | 670 | Unknown |
| Point-to-point radio | Kilowatts | N.A. | N.A. | 100 | Unknown |
| Telephone | | | | | |
| Interurban telephone channels | Kilometers | 5,000,000 b/ | 15,000,000 b/ | 200 | 40 percent automatic or semiautomatic |
| Urban exchange capacity | Subscriber lines | 2,078,000 | 3,117,000 | 50 | 90 percent |
| Rural exchange capacity | Subscriber lines | 500,000 | 1,000,000 | 100 c/ | 53 percent d/ |

* Footnotes for the table follow on p. 6.



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Table

Post and Telecommunications Facilities in the USSR
1958 and 1965 a/
(Continued)

| Type of Facility | Unit of Measure | End of 1958 | End of 1965 | Planned Increase (Percent) | Degree of Automation, 1965 |
|---|---|---|---|---|---|
| Telegraph | | | | | |
| Interurban telegraph channels | Kilometers | 3,700,000 e/ | 7,400,000 | 100 | Unknown |
| Subscriber telegraph | Number of subscribers | 1,500 | 15,000 f/ | 900 | 100 percent automatic or semiautomatic |
| Facsimile | Number of cities | 82 | 164 | 100 g/ | Unknown |
| Radiobroadcasting | | | | | |
| Transmitters (AM) | Kilowatts | N.A. | N.A. | 60 h/ | Unknown |
| Transmitters (FM) | Units | 55 | 220 | 300 | 100 percent i/ |
| Wire-diffusion centers | Units | 40,000 | 56,640 | 42 | 60 percent |
| Television | | | | | |
| Major transmitters | Units | 60 j/ | 160 j/ | 167 | Unknown |
| Relay transmitters | Units | 70 j/ | 290 k/ | 314 | 100 percent |



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Table

Post and Telecommunications Facilities in the USSR
1958 and 1965 a/
(Continued)

| Type of Facility | Unit of Measure | End of 1958 | End of 1965 | Planned Increase (Percent) | Degree of Automation, 1965 |
|---|---|---|---|---|---|
| Postal | | | | | |
| Postal enterprises | | | | | 100 percent mechanization and automation of 50 major postal enterprises<br><br>80 percent mechanization of 150 major postal enterprises |

a. 1/. (For serially numbered source references, see Appendix C.)
b. 2/
c. 3/
d. 4/
e. 5/
f. 6/
g. 7/
h. 8/
i. 9/
j. 10/
k. 11/



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point-to-point radio circuits, single-sideband radio facilities will use high-frequency transmitters having powers of 1, 5, and 20 kilowatts. Tropospheric scatter equipment will have a capacity of 60 to 120 telephone channels or 1 television channel per radiofrequency trunk.

Plans for the expansion of telephone and telegraph facilities are far less extensive than those for common carrier facilities, but the use of automated and modernized equipment will be emphasized. In urban, rural, and interurban telephone networks, modern crossbar exchanges are to be installed and existing automatic exchanges modernized. In the field of telegraphy, modern teletype apparatus will replace obsolescent Morse and Baudot equipment. Some automatic telegraph relay equipment will be available, but the primary innovation will be the use of perforated tape for semiautomatic relay. Automatic exchange equipment will be utilized in expanding the subscriber telegraph network, and modern apparatus will be introduced on subscriber and public facsimile networks.

Automation is the key to the ambitious expansion of broadcasting service. Amplitude-modulated (AM) and frequency-modulated (FM) radiobroadcasting stations will employ automated transmitters that can be remotely controlled and supervised. Television transmitters and wire-diffusion amplifiers will have similar automatic features. In addition, modern technology will permit the initiation of color television and stereophonic radiobroadcasting services.

In the postal system efforts will be concentrated on the mechanization of mail-handling operations. A limited amount of automation is planned for mail sorting, canceling, and vending operations. 12/

B. Plans, 1966-80

A fully automated telecommunications system and a highly mechanized postal system will be realized, according to Soviet publications, by 1980. This will be accomplished primarily through the continued expansion of those technologies introduced during the Plan, supplemented by some promising technologies now under development. The more prominent of these are given below.

Microminiature components. Microminiature components are useful, especially in solid-state form, for many purposes in communications equipment. They offer economy of operation, reduction in space requirements, high order of reliability, and extremely fast switching capability.

Electronic switching equipment. Electronic switching equipment can increase switching speeds as much as 1,000 times, simplify maintenance work, and permit reductions in equipment size and operating costs.



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Automatic high-speed data transmission systems. Data transmission systems greatly speed the rate-of-information transfer and improve reliability.

Long-distance waveguide and optical masers. Long-distance waveguide and optical maser techniques offer the advantage of an extremely broadband transmission, which can accommodate tens of thousands of telephone channels simultaneously. Costs-per-channel are expected to be lower than the costs of conventional common carrier facilities.

Communications satellites. Passive and active communications satellites present a potential for relaying communications signals over great distances.

The decision to introduce these technologies will be dependent not only on the successful conclusion of development work but also on cost considerations and service requirements. 13/

## III. Probable Success of Planned Technological Goals

Senior officials of the Soviet Ministry of Communications report substantial achievements during the first 3 years (1959-61) of the Plan and express optimism for the early fulfillment of the technological goals. Continuing progress also is reported on the development of new communications technologies.

### A. Achievements and Prospects, 1959-65

By the end of 1961, most of the modern technologies scheduled for introduction during the Plan had been introduced. Extensive work was accomplished during 1959-61 on the establishment of an arterial network of common carrier facilities. Major segments of several main and secondary microwave radio relay lines were completed and equipped with unattended relay stations. Two coaxial cable lines and at least two multiconductor cable lines, equipped with unattended repeaters, were put into service. Shortages of multiplexing equipment prevented the utilization of these lines at designed capacity. It is assumed that these shortages will continue through 1965, but plans for constructing microwave and cable lines probably will be achieved.

Research work continued on radio scatter techniques during 1959-61. Several circuits began experimental operations, but the slow progress in establishing regular service suggests developmental difficulties.

The design of single-sideband transmitters operating in the high-frequency range was completed in 1960, and operational use was scheduled for 1961. The planned extensive use of single-sideband transmitters should be realized by 1965.



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The planned introduction of automatic urban, rural, and interurban telephone exchanges was fulfilled in 1959-61. Automatic telephone service (direct distance dialing) was initiated, joining Moscow, Leningrad, and Kalinin. Semiautomatic connection (operator distance dialing) of interurban calls was introduced between Moscow and several republic capitals. To modernize automatic telephone exchanges of the rotary type, a prototype of all-relay registers was put into experimental operation in Leningrad in 1960 and in Moscow in 1961. It was reported cryptically that an electronic telephone exchange with a capacity of 10,000 lines had been "designed" in Leningrad.

No obstacles were encountered in 1959-61 to impede the achievement of technological goals in telegraphy. Baudot and Morse equipment was replaced in many rural areas with modern teletype apparatus, greater use was made of perforated tape for the semiautomatic relay of telegraph traffic, and modern facsimile apparatus was introduced. The first automatic exchange for the relay of telegraph traffic was put into operation in Estonia in late 1960, and similar exchanges were to be installed in 1961 in Latvia and Lithuania and in parts of Belorussia.

Automation of broadcasting in the USSR made good progress during 1959-61. Many automatic television relay transmitters became operational, and the first automated television transmitter was put into service in Estonia in 1961. Developmental work was begun on a standard television transmitter in the ultrahigh-frequency range, and several automated FM relay transmitters began broadcasting. A high level of automation was achieved in the urban wire-diffusion networks. Developmental work continued on stereophonic radiobroadcasting and multiprogram wire-diffusion broadcasting. The only problem area apparent in the technical improvement of broadcasting is in wire-diffusion service. In consequence of low priority, wire diffusion suffers from shortages in equipment and from inadequate research facilities and manpower.

Mechanization of postal operations proceeded as planned in 1959-61 in spite of several difficulties, chiefly related to resolving equipment standards in the face of installation in nonstandard buildings. Continued success is anticipated.

Achievements registered during 1959-61 are indicative of probable success in all but a few areas of planned technology. Those areas encountering difficulties should not seriously restrict the over-all level of technology. 14/

B. Prospects, 1966-80

As most of the modern technologies anticipated for 1966-80 will be a continuation of those presently being introduced, Soviet prospects



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for 1966-80 appear to be favorable. Moreover, the economic attractiveness of new technologies now being investigated, in addition to the growing service requirements envisaged, should provide the stimulus for the adoption of even more advanced communications systems and techniques.

C. Problems

The success of the Ministry of Communications in meeting its technological goals is largely dependent on the timely and adequate supply of equipment from the electronics industry. There have been some lags in equipment deliveries experienced in the past 3 years as well as instances of equipment not meeting design standards. Considerable trouble was encountered, for example, with the supply and quality of 60-channel telephone multiplexing equipment. Should these problems become more widespread, over-all plan fulfillment will be jeopardized.

Although the seriousness of these difficulties is not fully apparent, their continuation could affect the operational status of new technologies. 15/

## IV. Impact of Technological Advances on the Post and Telecommunications Sector

The full impact on the post and telecommunications sector of the technologies being introduced in the USSR will not be felt until after 1965. This is especially true of the increase in the quantity of service available. A sharp rise in the availability of service will not occur until after 1965. Concomitant improvements in capital-output ratios and in labor productivity also will occur.

### A. Services

With the exception of broadcasting and subscriber telegraph (TELEX) service, most of the technological advances during the Plan will not result directly in a large increase in services rendered, especially telephone service. Instead, they will be employed predominantly to establish the hard core of a nationwide network of common carrier media. Initially these facilities will be mainly for network radio and television service.

After 1965, emphasis probably will shift to the application of modern telephone and telegraph exchange equipment to the new media. As a consequence, substantial increases in service volumes will follow.

In addition, after 1965 the Ministry of Communications will be able to offer many new specialized services. These services probably



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will include the following: data transmission (teledata), remote control (telecontrol), remote operation (telemechanics), remote metering (telemetering), closed circuit television, and the leasing of broadband circuits to meet multiservice needs.

B. Investment and Revenue

The technological advances contemplated in the Plan have enlarged requirements for capital investment. An investment fund of 15 billion 1958 rubles has been allotted for 1959-65, an amount double that for the previous 7 years.* Even larger investments are anticipated in subsequent years in order fully to realize technological goals. 17/

The allocation of 1959-65 investment funds within the Ministry is estimated to be as follows: common carrier, 37 percent; broadcasting, 25 percent; telephone, 15 percent; postal, 15 percent; housing, 5 percent; and telegraph, 3 percent. This breakdown reflects the relative priority that the Ministry is giving to the development of its various services. Future allocations probably will show a greater emphasis on telephone and telegraph service.

The efficiency of capital investment in modern equipment will not be evident until after 1965. In fact, the 1959 capital-output ratio of 1.75 to 1 will become less favorable by 1965, a situation that will be directly attributable to a lag in the utilization of common carrier facilities by revenue-producing services.**

After 1965 the utilization of the common carrier network will rise sharply as priority is given to the automation of telephone and telegraph facilities. An additional factor that will improve capital-output ratios after 1965 is the potential which will then exist for expanding the capacity of the common carrier network at relatively low investment costs.

C. Manpower

As most technological developments during the Plan will not directly contribute to increases in post and telecommunications service

* The first capital inventory conducted by the Ministry of Communications in 1959 placed the capital value of its facilities at 21.9 billion rubles (replacement cost expressed in current prices). 16/ All ruble values in this report are given in old rubles (ruble values in use before the Soviet currency reform of 1961) and may be converted to US dollars at the rate of exchange of 6 rubles to US $1, which reflects the relationship between the US and the Soviet post and telecommunications sectors.

** It is estimated that revenue will increase from 12 billion rubles in 1958 to 20 billion rubles by 1965 (1958 prices).



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volumes, labor productivity gains (measured in terms of output per worker) will be modest. Technologies applied to service-generating facilities after 1965, however, should measurably improve labor productivity.

Some of the benefits of past growth in labor productivity have been passed on to the labor force in the form of shorter hours and increased wages. The workweek was reduced from 46 to 41 hours in 1960 and will be reduced to 40 hours in 1962. Average wages were increased in 1960-61 by 25 to 30 percent. Some low-wage workers, mainly postal and telephone, received increases as high as 50 percent.

Even with technological progress, the size of the labor force will continue to grow. Technological changes, however, will induce changes in the composition of the labor force through greater demands for engineers and technicians.

To insure that the fruits of technology are realized fully, the Ministry has made all communications enterprises financially accountable. In addition, material incentives to both enterprises and individuals have been increased for aboveplan fulfillment. 18/

## V. Significance of Telecommunications Advances to the Soviet Economy

Technological advances in the post and telecommunications sector are preparing the way for a fundamental change in the planning and control mechanisms of the Soviet economy. The development of an arterial network of common carrier facilities interconnecting all major centers of economic activity will shortly permit the introduction of many modern telecommunications services. These services will include the following: automatic telephone and telegraph service; teledata service for the transmission of large quantities of statistical data to computer centers as well as between computer centers; and telecontrol, telemechanical, and telemetering services to meet the specialized needs of power networks, railroads, water reservoirs, gas and oil pipelines, metallurgical combines, and other industries.

The use of these new services will revolutionize the speed and accuracy of economic planning. They also will help to effect better operational control and coordination of the whole economy. Their existence will allow industry to proceed with its plans for the automation of its variegated processes. But these services will not be available in any appreciable quantity until after 1965. 19/

## VI. Relative Status of Applied Telecommunications Technology in the US and the USSR

Few areas of scientific endeavor have made such rapid strides in the last 15 years as communications electronics. Western countries have not



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hesitated to put these scientific discoveries to practical use. This has not been the case in the USSR. In spite of demonstrated capabilities in the science of communications electronics, the USSR only recently has begun to turn its science to practical exploitation.

The relative status of telecommunications technology in the US and the USSR is shown by the following comparisons of major communications systems:

1. Microwave radio relay facilities were introduced in the US in 1947 and in the USSR in 1956. In 1960, there were more than 55,000 miles of microwave radio relay lines in operation in the US and about 5,000 miles in the USSR. The latest US microwave system, the TH, has eight duplex trunks, each of which can carry 1,860 telephone channels. The most modern Soviet microwave system, the Vesna (R-600), has six duplex trunks, each of which can carry 600 telephone channels. The Vesna is comparable to the TD-2, which was put into transcontinental use in the US in 1951.

2. Tropospheric scatter systems have been in commercial use in the US since the inauguration of the Florida-Cuba link in 1957. A tropospheric scatter network extending 3,000 miles was put into service in Alaska in 1958, and an additional link was established between Florida and the Bahamas in 1959. The use of the tropospheric scatter medium for communications in the USSR is only beginning now.

3. Coaxial cable had its origin in the US in 1936. The first coaxial cable line in the USSR was laid shortly after World War II, but apparently its performance was faulty. In 1960, there were 100,000 tube miles of coaxial (chiefly 6- or 8-tube) cable in the US and about 600 route miles of coaxial (chiefly 4-tube) cable in the USSR. Multiplexing equipment employed on coaxial pairs in the US yields a maximum of 1,860 telephone channels, whereas 1,920 telephone channels are possible in the USSR.

4. Automatic switching of interurban calls (direct distance dialing -- DDD) commenced in the US in 1951 and in the USSR in 1959. Of the 70 million dial-operated telephones in the US in 1961, 50 percent were able to make DDD calls to 90 percent of the dial-operated telephones. It is estimated that the USSR, with 1.5 million dial-operated telephones in 1961, had DDD service to 100,000 dial-operated telephones located in only three cities.

5. The regular telegraph network of the US began the automatic relay of telegraph traffic in the late 1940's. By the end of 1961, 12 of the 15 major relay offices serving the whole US had been automated. The first telegraph relay office in the USSR was automated in 1960. A total of 4 relay offices was to have been automated by the end of 1961.

6. Subscriber and leased telegraph facilities are used extensively in the US. In 1960, there were about 30,000 subscribers in the



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two subscriber telegraph networks (TELEX and TWX) of the US. Both of these networks will be fully automatic by the end of 1962. The comparable Soviet network had 6,900 subscribers in 1960 and will be automated by 1965. In the US in 1960, subscriber facsimile service (Desk-Fax) was available in 200 cities, leased facsimile service (INTRAFAX) in more than 300 cities, and public facsimile service (WIREFAX) in 5 cities. Public facsimile service was available in nearly 100 cities in the USSR in 1960 and to an unknown number of private subscribers.

In the US, there are a number of new communications techniques and services, in various stages of experimental and operational use, for which there are no known counterparts at present in the USSR. The more significant of these are the following:

1. The world's first electronic telephone exchange (electronic central office -- ECO) began experimental operation to 400 subscribers in November 1960. ECO, which is fully automatic and has no moving contacts, operates 1,000 times faster than conventional crossbar exchanges and provides a number of unique services to subscribers. ECO also incorporates many automatic error-detecting and error-correcting features. A production-model ECO is being designed at the present time.

2. TELPAK service, introduced in 1961, involves the leasing of circuits having band-widths of 12, 24, 60, and 240 telephone channels to business and government users. These channels can be used for telephone, telephotograph, facsimile, teletype, teledata, telecontrol, telemetering, and other signals.

3. A Pulse Code Modulation (PCM) telephone transmission system began experimental operation between two urban areas in 1961. Instead of sending a continuous voice signal, PCM samples speakers' voices 8,000 times per second, encodes these samples, transmits the coded binary pulses, and then reconstructs the original voice at the receiving end. By the use of PCM the capacity of a pair of wires in a cable designed for a single conversation can be increased to 24 telephone conversations. This system was designed for use in urban areas on routes of up to 25 miles. It avoids the high cost of laying more cables in urban areas. Repeaters are required every 6,000 feet.

4. Time Assignment Speech Interpolation (TASI), a time-sharing technique, was first introduced on the transatlantic cable in 1960. By means of electronic scanning and switching, TASI doubled the capacity of the transatlantic cable from 36 to 72 telephone conversations.

5. Data-Phone service permits the transmission of data signals over ordinary telephone facilities, in many cases between business machines. Data can be taken from paper tape, magnetic tape, punched cards,



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and teletypewriters for transmission over a normal telephone circuit at a speed equivalent to 2,500 words a minute. About 1,100 Data-Phones were in operation in 1960. Presently being introduced to work with the Data-Phone is the Phonewriter for the instantaneous transmission of handwriting and sketches.

6. CENTREX is a modern telephone service for private branch exchanges (PBX). Most of the equipment for many PBX customers is located in one central place. CENTREX service permits the direct inward dialing (DID) of PBX extensions, the direct outward dialing (DOD) from PBX extensions, and the interconnection of PBX extensions by dial. CENTREX served 400,000 PBX telephones in 1961.

7. "Bellboy Service" consists of a pocket radio receiver that emits an audible signal when a subscriber, away from his telephone, is wanted on the telephone. This service was available in 27 cities in 1961. 20/

From these and other comparisons it is apparent that telecommunications technology in the USSR lags behind that in the US by about 10 years. This disparity can be attributed to differences in the size of the two systems and to differences in concepts of serviceability. In order for the already large US system to expand and optimize its services following World War II, it was an economic necessity to develop new technologies to provide new services and at the same time to cope with the growing switching (interconnection) problem, which varies geometrically with the size of the system. In contradistinction, the much smaller Soviet system with its concept of minimal serviceability induced many fewer economic stimuli for technological advancement.

The accelerated pace of US technology since World War II is proving to be beneficial to the USSR. Now that the USSR is building a modern telecommunications system, it can adopt US technologies -- and of course those of other modern industrial countries -- at a great savings in developmental time and money. Furthermore, because the USSR did not adopt many interim technologies as they became available, it can now avoid what otherwise would have been the economic cost of rapid obsolescence or, alternatively, the cost of achieving compatibility of a total system from a conglomerate of incompatible subsystems.

In summary, it is expected that the USSR will, over the long term, reduce discernibly its present lag behind the US. But because the US will continue to exploit over the period the revolutionary developments in the field of electronic technology as they become economically attractive, it is doubtful that even by 1980 the lag will have been eliminated.



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APPENDIX A

## GLOSSARY OF TECHNICAL TERMS

Amplitude modulation (AM): The process by which a selected carrier frequency is varied in magnitude (amplitude) by other frequencies that contain the information to be transmitted in telecommunications. (See Frequency modulation.)

Apparatus: Instruments, machines, appliances, and other assemblies used in providing a telecommunications facility.

Automatic (as an adjective): Of or pertaining to any process involved in producing telecommunications service that does not require direct, immediate human assistance.

Band (of frequencies): The entire range of frequencies between two numerically specified frequency limits. The magnitude of this range is a limiting factor on the amount of information that can be transmitted in telecommunications. With respect to frequencies of the radio spectrum as a whole, the International Telecommunication Union has for convenience divided the whole radio spectrum into eight major bands, as follows:

Frequency Bands

| Range | Type | Corresponding Wave* Band |
|---|---|---|
| Up to 30 kc** | Very low frequencies (VLF) | Myriametric waves |
| 30 to 300 kc | Low frequencies (LF) | Kilometric waves |
| 300 to 3,000 kc | Medium frequencies (MF) | Hectometric waves |
| 3,000 to 30,000 kc | High frequencies (HF) | Decametric waves |
| 30,000 kc to 300 mc*** | Very high frequencies (VHF) | Metric waves |
| 300 to 3,000 mc | Ultra high frequencies (UHF) | Decimetric waves† |
| 3,000 to 30,000 mc | Super high frequencies (SHF) | Centimetric waves† |
| 30,000 to 300,000 mc | Extremely high frequencies (EHF) | Millimetric waves† |

* Waves are undulating disturbances: a sound wave is a disturbance in the air, which is an elastic medium, and an electric wave is a disturbance in any medium whatever. The number of waves per second is the frequency of a given wave. Because the speed of wave propagation is considered to be constant, the length of a given wave is in inverse relation to its frequency: the longer the wave length, the lower the frequency; and the shorter the wave length, [footnote continued on p. 18]



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Cable: A bundle of sheathed, insulated wires and/or coaxial tubes used as a telecommunications medium. It is sometimes referred to as "multiconductor cable."

Carrier (as an adjective): Of or pertaining to a technique for dividing a circuit, lane, supergroup, group, or channel into portions that can be used independently of and simultaneously with all other portions. Different frequencies or different pulses are selected for each portion to "carry" the information to be transmitted, after alteration by the information frequencies. The carrier itself need not be transmitted.

Channel: A portion, electrical or physical, of a telecommunications circuit, lane, supergroup, or group that can be used to transmit information independently of and simultaneously with all other portions. A channel may be used to provide two or more subchannels.

Circuit: A telecommunications connection between two or more distant points by a wire, cable, or radio medium facility used to carry information. The circuit is the fundamental telecommunications connection between distant points. By the application of appropriate techniques, a circuit may be arranged in many different combinations to meet the need for various kinds and quantities of telecommunications service. In its simplest form a circuit may carry only single telecommunications units in sequence. In its most complex form it may by apportionment carry simultaneously thousands of telephone channels and telegraph subchannels; a number of television programs; and other specialized kinds of service, such as high-fidelity broadcast programs, radar signals, and data-processing signals.

For the most complex application, a circuit is often arranged into lanes, each of which can carry, in one direction, 1 television program or up to 1,800 telephone channels. In turn, these 1,800 telephone channels are subdivided into 10 supergroups of 60 telephone channels each. Each supergroup is subdivided into 5 groups of 12 telephone channels each. One or more telephone channels may be further subdivided into 3 to 20 sixty-word-per minute teletype subchannels. Other specialized kinds of service may be accommodated by combining two or more telephone channels.

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the higher the frequency. Wave length usually is measured in linear units of the metric system.

** Kilocycles per second, or 1,000 cycles per second.

*** Megacycles per second, or 1 million cycles per second.

† It is becoming common usage to refer to waves (frequencies) in these three bands as "microwaves."



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Coaxial (as an adjective): Of or pertaining to a modern telecommunications cable medium technique using one or more tubes (sometimes called "pipes"). Each metal tube surrounds a conducting wire supported concentrically by insulators. The space in the tube usually contains nitrogen gas under pressure. Generally, coaxial cable is used for the transmission of information in complex form, such as radar, computer data, or television signals, and/or for the transmission of telephone channels and telegraph subchannels. A single tube usually carries information in only one direction at a time. The capacity of a tube depends in part on the distance between repeater stations. In the standard facility, which may have from 2 to 8 tubes in the cable, a single tube carries a lane of up to 1,800 telephone channels or 1 television lane, for which the repeater station spacing is about 7 statute miles. In a new developmental coaxial cable facility, a single tube may carry 3 lanes of a total of 1,800 telephone channels or 3 television lanes, for which the repeater station spacing is expected to be about 3 statute miles.

Electronics: A general term used to identify that branch of electrical science and technology which treats of the behaviour of electrons in vacuums, gases, or solids. Today telecommunications makes extensive use of electronic technology.

Facility: An association of apparatus, material, and electrical energy required to furnish telecommunications service.

Facsimile (as an adjective): Of or pertaining to a telecommunications (telegraph) service in which photographs, drawings, handwriting, and printed matter are transmitted for graphically recorded reception. In one method (Type A), images are built up of lines or dots of constant intensity. In another method (Type B), images are built up of lines or dots of varying intensity, sometimes referred to as "telephoto" and "photoradio."

Feeder (as an adjective): Of or pertaining to telecommunications facilities of relatively low capacity that join facilities of relatively high capacity. (See Main.)

Frequency: The rate in cycles per second at which an electric current, voltage, wave, or field alternates in amplitude and/or direction. (See Band.)

Frequency modulation (FM): The process by which a selected carrier frequency is varied in frequency by other frequencies that contain the information to be transmitted in telecommunications. (See Amplitude modulation.)



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Functional (as an adjective): Of, pertaining to, or connected with special, unique, or particular telecommunications facilities managed and operated by a single agency, organization, company, department, committee, ministry, or other entity, in contrast to the facilities of a basic system. (See Basic system.)

Group: A number of channels (usually 12) or subchannels combined (multiplexed) electrically in building up the total capacity of a telecommunications circuit, lane, or supergroup.

Ionosphere: Those layers of the earth's atmosphere occupying the space about 210 statute miles in thickness extending from about 30 statute miles above the earth's surface to the outer reaches (exosphere) of the atmosphere. Reflection from these layers makes possible long-distance transmission of radio signals. The layers, however, are responsible for fading of signals, skip distance, and differences between daytime and nighttime radio reception. The layers also are used as a scattering reflector for ionospheric scatter-transmission techniques to transmit to distances of about 1,000 to 1,500 statute miles.

Joint facility: A telecommunications facility owned, controlled, or operated by two or more agencies, organizations, companies, departments, committees, ministries, or other entities.

Lane: A one-way portion, electrical or physical, of a two-way telecommunications circuit that can be used independently of and simultaneously with all other portions. The largest lane today can handle 600 telephone channels or 1 television program. In some applications the direction of a lane may be reversed.

Leased (as an adjective): Of or pertaining to the direct operation by a user of a telecommunications facility owned by another agency.

Line: A general term used to delineate a telecommunications circuit facility (wire, cable, or radio).

Main (as an adjective): Of or pertaining to telecommunications facilities at and between principal cities and centers that have relatively high capacity compared with feeder facilities. (See Feeder.)

Medium: Any substance or space that can be used practically to transmit a form of electrical energy for the purpose of providing telecommunications service.

Microwave radio relay (as an adjective): Of or pertaining to a radio medium technique in modern telecommunications employing radio frequencies higher than 300 mc. These frequencies normally do not afford



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practical direct transmission to great distances, principally because they do not bend well around the earth's surface and because they do not reflect well from the ionosphere. They are, however, capable of reliable transmission from horizon to horizon (line-of-sight) by the use of special antennas that concentrate the radio energy and give it desired direction. In consequence, great distances can be reached by this technique by the interposition of relay stations along the route of the line with a spacing interval of from 25 to 40 statute miles, depending on terrain conditions. This technique can be employed practically to carry from a small number of telephone channels and telegraph subchannels to thousands of such channels and subchannels through two or more lanes and to carry one of more television and other specialized lanes and channels. (See Band.)

Mobile (as an adjective): Of or pertaining to a telecommunications facility that is intended to be operational while in motion or during halts at unspecified points. (See Portable.)

Modulation: The process of altering a carrier frequency or carrier pulses by other frequencies or pulses representing the information being transmitted.

Multiplex (as an adjective): Of or pertaining to the combining of information signals, modulated or unmodulated, of two or more lanes, supergroups, groups, channels, or subchannels for transmission over the same circuit.

Network: An interconnection, electrical or physical, of two or more circuits or portions thereof for the purpose of facilitating telecommunications service.

Point-to-point (as an adjective): Of or pertaining to telecommunications service between fixed points, using the radio medium.

Portable (as an adjective): Of or pertaining to a telecommunications facility that can be readily moved from place to place but normally is not operational while in motion. (See Mobile.)

Private (as an adjective): Belonging to or concerning an individual person, organization, institution, or activity; not public or common.

Pulse: A spurt of electrical energy of extremely short duration (usually measured in millionths of a second) yet capable of being used in telecommunications to transmit information.

Quad: In a multiconductor telecommunications cable, the physical association of a group of four conductors in any one of various arrangements for the purpose of providing two-way multichannel operation.



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Reception base: The aggregate telecommunications receiving facilities employed in providing a broadcast service.

Route: The geographical path followed by a wire, cable, or radio line.

Scatter (as an adjective): Of or pertaining to a radio medium technique in modern telecommunications by which energy in radio frequencies above 30 mc is deliberately scattered into one or the other of two reflecting portions of the atmosphere (troposphere and ionosphere) at such a predetermined angle that a usable portion of the energy arrives at the desired receiving location. This technique is especially applicable to regions in high latitudes (Arctic and Antarctic) where facilities of other media suffer from the rigors of weather and terrain and where the conventional long-distance radio media of the lower frequency bands (200 kc to 30 mc) are subject to serious disruptive propagational anomalies. (See Band.)

Subchannel: A portion, electrical or physical, of a telecommunications channel that can be used independently of and simultaneously with all other portions. An appreciable number of telephone channels usually can be subchanneled to carry from 3 to 20 sixty-word-per-minute teletype subchannels on each telephone channel so employed.

Subscriber: Any customer who directly operates telecommunications apparatus in obtaining telecommunications service.

Supergroup: A number of groups (often five) combined (multiplexed) electrically in building up the total capacity of a telecommunications circuit or lane.

System: All of the facilities and networks managed by a single agency, organization, company, department, committee, ministry, or other entity in rendering either functional or basic telecommunications service.

Telecommunications: Transmission, reception, or exchange of information between distant points by electrical energy over a wire, cable, or radio medium facility to produce telephone, telegraph, facsimile, broadcast (aural and visual), and other similar services.

Teletype (as an adjective): Of or pertaining to a technique for effecting telegraph service by the use of an apparatus similar to a typewriter in which information is transmitted by keyboard and received by type printer on a roll of paper or tape or by perforations on a roll of tape or both. The apparatus is sometimes called a "teleprinter" or a "teletypewriter."



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Transmission base: The aggregate telecommunications transmitting facilities employed in providing broadcast service.

Transistor: A modern device that is capable of performing in a solid (germanium or silicon) many of the functions performed by the conventional electronic tube in a gas or vacuum.

Troposphere: The layer of the earth's atmosphere occupying the space from the earth's surface to a height of about 6 statute miles. This layer is used as a scattering reflector for tropospheric scatter-transmission techniques to distances of about 200 to 500 statute miles.

Wave guide (as an adjective): Of or pertaining to a telecommunications medium, now under development in several countries, that may be capable of transmitting extremely large amounts of conventional and complex information. It consists of a circular or rectangular hollow metallic tube in which electrical energy travels in the form of waves, much as do sound waves in a speaking tube.

Wire diffusion: Distribution of broadcast programs by a wire or cable medium to wired loudspeakers.

Wired loudspeaker: A telecommunications loudspeaker that receives from a distribution point one or more broadcast programs by a wire or cable medium.

Wireline: A general term used to identify a line consisting of either an aerial cable (and/or separate wires) or an underground cable used as a telecommunications medium.



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